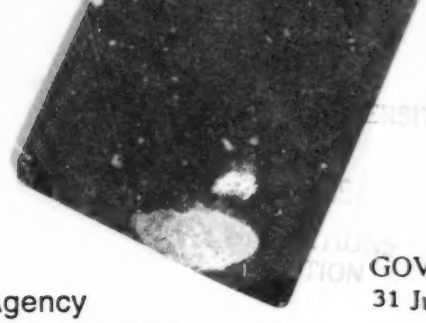

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PLAN FOR PRODUCING POTABLE WATER ECONOMICALLY

Report by the Director General to the Board of Governors and the General Conference

I. Introduction

1. Last year, the General Conference had before it documents GOV/2855-GC(40)/4 and GC(40)/4/Add.1, which summarised the progress of various studies and activities initiated by the Agency on the topic of "Plan for producing potable water economically." The documents also contained a summary of the "Options Identification Programme (OIP)," which had been carried out for two years from September 1994, upon resolution GC(38)/RES/7 and completed with the publication of the IAEA TECDOC-898. Following discussions based on information provided by these documents, the General Conference adopted resolution GC(40)/RES/14.

2. Noting the continuing interest of a number of Member States in seawater desalination using nuclear energy and stressing the importance of adequate potable water supplies for mankind, the General Conference, in resolution GC(40)/RES/14, requested the Director General to continue consultations with interested Member States, the competent organisations of the United Nations system and other relevant intergovernmental organisations, to establish an advisory body on the Agency's activities relating to nuclear seawater desalination, and to take appropriate measures to assist Member States concerned in the process of preparatory actions for demonstration projects. The present document provides, as requested by the resolution, the progress made in the implementation of this resolution. It is being issued for the attention of both the Board of Governors and the General Conference.

II. Consultations with Member States and International Organisations

3. Resolution GC(40)/RES/14 requested the Secretariat to continue consultations with interested Member States concerning the main conclusions of the IAEA TECDOC-666 on "Technical and economic evaluation of potable water production through the desalination of seawater by using nuclear energy or other means." The Secretariat has also undertaken consultations concerning the main findings reported in the IAEA TECDOC-898 on "Options

97-02766

identification programmes for demonstration of nuclear desalination plants" and the subsequent progress. Seventeen Member States supported the Agency's activities by providing either cost-free experts, extrabudgetary resources or experts for meetings and/or consultancies.

4. Also acting on resolution GC(40)/RES/14, the Secretariat invited comments from the competent organisations of the United Nations system and other relevant intergovernmental organisations, concerning the main conclusions of the above mentioned IAEA TECDOCs. As of June 1997, three international organisations, UNIDO, UNDP and WMO, have responded. WMO has reconfirmed that it shares the Agency's position that nuclear seawater desalination offers important possibilities for overcoming critical water shortages in certain regions of the world. UNIDO has recognised the importance of desalination of seawater and has agreed to cooperate in the preparation of the Symposium on " Desalination of Seawater with Nuclear Energy." UNDP has requested to be kept informed about the future development of nuclear seawater desalination. No other concrete proposals have been received. In addition to consultations concerning the conclusions of the above mentioned TECDOCs, consultations with some other intergovernmental and non-governmental organisations have been undertaken to exchange data and expertise. Economic and Social Commission for Western Asia (ESCWA) of UN invited the Agency to its meeting on "Development of Non-conventional Water Resources in the ESCWA Region," scheduled for October 1997. FAO has provided the Agency's Secretariat with its new publication series titled "Land and water electronic newsletter." This newsletter contains information about natural water resources mainly for agricultural use. The World Bank has responded with an appreciation to the Agency's interaction regarding its next meeting on "Water for Sustainable Growth" planned to be held at the end of 1997 or beginning of 1998 with sponsorship by the European Commission and the European Investment Bank. The meeting is a new initiative to confront regional problem in the water sector, in particular for the Middle East and North Africa.

III. Activities Carried out or Planned in Nuclear Desalination 1996 - 1997

5. In response to the resolution GC(40)/RES/14, the Secretariat convened an AGM in October 1996 in order to get advice and recommendations on "Next steps in the Agency's nuclear desalination programme." The AGM

- endorsed the organization of the Symposium on "Desalination of Seawater with Nuclear Energy,"
- requested the Agency to perform a more detailed economic assessment of nuclear desalination versus other desalination options,
- recommended the establishment of a database for non-electrical applications of nuclear energy,
- recommended the preparation of a Guidebook on "Introduction of Nuclear Desalination" and the identification of user requirements,
- proposed the establishment of a Co-ordinated Research Programme (CRP) on "Optimization of the Coupling of Nuclear Reactors and Desalination Systems," and
- provided advice on the TERMS of REFERENCE for the International Nuclear Desalination Advisory Group (INDAG) to be established by the Agency.

1. Symposium on "Desalination of Seawater with Nuclear Energy"

6. In order to provide a forum for reviewing the latest technological experience, design and development and prospects of nuclear seawater desalination, an international Symposium on "Desalination of Seawater with Nuclear Energy" was held in May 1997 in Taejon, Republic of Korea. The Symposium was organized in co-operation with the International Desalination Association (IDA) and the Global Technology Development Centre (GTDC). Preparation of the Symposium was made with participation from IDA, GTDC, WHO, UNIDO, EC and several Member States. The Symposium was hosted by the Korea Atomic Energy Research Institute, and attended by about 250 participants from about 30 Member States and international organizations. Overview of activities on desalination was given by participants from selected organizations; experiences from existing nuclear desalination plants and relevant conventional desalination facilities were reported; national and bilateral activities including research, design and development aspects in nuclear seawater desalination were presented; and forecasts and challenges lying ahead were discussed. The Symposium with large attendance from the nuclear power and the desalination sectors proved to be a useful forum for exchange of information on nuclear desalination programmes and on technical and economic aspects of different desalination processes.

7. During the Symposium Japan and Kazakstan provided detailed information about their experience with nuclear desalination complexes. The Republic of Korea reported its programmes in technology development and design for a 330 MWth reactor for co-generation of heat and electricity. One possible application of this reactor is desalination of seawater. India presented its plan to connect a hybrid loop of the Multi-Stage-Flash (MSF) and the Reverse Osmosis (RO) systems to the existing pressurized heavy water reactors (PHWRs) at Madras Atomic Power Station. China reviewed the application potential of its heating reactor for district heating and desalination. New potential sites for nuclear desalination in China have been identified. Morocco reported the status of its pre-project study on nuclear desalination, which includes a 10 MWth heating reactor to be supplied from China for a desalination complex to be built at Tan-Tan in South Morocco. Russia reported its small reactor plants for desalination.

8. Continued Agency's involvement in international and regional co-operation and information exchange was stressed including its activities in public acceptance and demonstration of economic feasibility of nuclear seawater desalination plants. The majority of participants shared the view that nuclear seawater desalination is technically feasible. The cost of the plant and the social acceptability were recognized as remaining major issues. To overcome these issues, international and regional co-operation was stressed including close collaboration with IDA. After many technical and economical studies performed under the umbrella of the IAEA, the next step should be to demonstrate the technical and economic feasibility of nuclear seawater desalination by proceeding with effective development and practical applications.

2. Economic Assessment

9. Previous IAEA studies have shown that nuclear energy would be competitive with fossil energy for desalination in a range of situations. This applies in particular to countries which lack cheap indigenous energy resources, need large amounts of desalted water, and have the means and infrastructure to install a medium size nuclear power plant. In order to evaluate site-specific technical and economic conditions of seawater desalination, a computer code has been developed by the Agency. The code and respective Computer Manual No. 12, "Methodology for the economic evaluation of cogeneration/desalination options" are now available to interested Member States. The code was presented during the above-mentioned Symposium in Republic of Korea. A training workshop for North African countries will be held in Casablanca, Morocco, in September 1997. Currently this code is being further developed in the framework of a study on "In-depth economic assessment of nuclear seawater desalination". More detailed cost components are being included and additional coupling configurations of energy sources with desalination processes have been integrated to better estimate competitiveness of nuclear desalination versus conventional desalination.

10. The IAEA published IAEA-TECDOC-942 containing an economic ranking methodology for different cogeneration plants. The TECDOC also contains results of its application to potential sites on the Arabian peninsula.

3. Database Development for Non-electrical Application of Nuclear Energy

11. In order to share experience in nuclear heat applications, the IAEA initiated preparatory work for an expansion of the existing Power Reactor Information System (PRIS) database for non-electrical applications of nuclear energy, such as district heating and desalination. The expanded database is being designed to encompass plant design specifications, performance data, operating and outage statistics and other relevant information on nuclear plants for non-electrical applications. Data collection on nuclear heat application is already in progress.

4. Guides and User Requirements for demonstration projects

12. In order to provide guidance to Member States in their planning and implementation of nuclear desalination plants, the Agency is preparing a Guidebook on "Introduction of nuclear desalination" scheduled to be finished in about three years. The basic structure of the Guidebook will be:

PART I. Overview of nuclear desalination;
PART II. Special aspects and considerations relevant to the introduction of nuclear desalination; and
PART III. Steps to introduce nuclear desalination.

13. Furthermore, the identification of user requirements for nuclear desalination plants was started. Although some requirements are site dependent, a general harmonized approach to nuclear desalination plants is desirable for cost reduction purposes. User requirements for nuclear desalination comprise those for the nuclear plant, the desalination plant and their

coupling. Since most potential nuclear desalination users are in the developing countries with limited nuclear power experience, identification of user requirements for nuclear plants plays an important role. The AGM in July 1997 on "Small and medium size reactor (SMR) requirements for developing countries" provided a useful forum for the discussion of necessary steps to be taken by Member States to identify such requirements

5. A New Co-ordinated Research Programme (CRP)

14. The Agency's 1998 Programme and Budget includes now a new CRP for 1998-2003 on "Optimization of the Coupling of Nuclear Reactors and Desalination Systems," The proposed CRP would encompass research and development programmes focused on optimization of the coupling of nuclear and desalination systems in the following major areas:

1) Nuclear reactor designs intended for coupling with desalination systems
2) Optimization of thermal coupling of NPPs and desalination systems
3) Performance improvement of desalination systems for coupling
4) Advanced desalination technologies for nuclear desalination

As of July 1997 nine Member States have shown interest in this CRP. The first Research Coordination Meeting is planned for 1998.

6. Pre-demonstration Project Study

15. The Agency has been providing technical assistance to the Government of Morocco since 1995, within the framework of a technical co-operation project (MOR/4/012). Morocco has started a joint pre-project study on demonstration of nuclear desalination with China. In the study, a multi-effect distillation (MED) desalination process to produce 8 000 m3/day connected to a 10 MWth heat-only nuclear reactor proposed by China is considered. The site of the nuclear desalination plant has been determined to be located at Tan-Tan, south Morocco. Currently, siting requirements and conditions are being evaluated. To allow Moroccan institutes to perform own calculations for the Chinese heating reactor, the transfer of expertise and computer codes on thermal-hydraulics, physics and safety analyses is currently taking place.

7. Educational Computer Codes on SMRs

16. All reactors recommended in the framework of the OIP for the demonstration of nuclear desalination are in the small to medium size range. A computer code has been developed to provide an educational tool to observe and compare the general response of various power reactor types to a variety of operational and accident conditions. The code gives insight to and understanding of the design and operational characteristics of various power reactor systems in that size range. The package is aimed particularly to developing Member States interested in the utilization of nuclear power. The code can be operated on a personal computer with enhanced capabilities. A training course has been scheduled for late 1997 in Cairo, Egypt, in the framework of the Technical Cooperation Project (RAF/4/013) on Seawater Desalination using Nuclear Energy - Regional Training Course on "Simulation of Advanced Water Cooled Reactors."

8. Publications

17. During the past year, the following documents in the field of nuclear desalination have been published or are currently in the process of publication.

- Options Identification Programme for Demonstration of Nuclear Desalination, IAEA-TECDOC-898, Vienna (1996)
- Potential for Nuclear Desalination as a Possible Source of Low Cost Potable Water in North Africa, IAEA-TECDOC-917, Vienna (1996)
- Methodology for the Economic Evaluation of Cogeneration/Desalination Options: A User's Manual, IAEA-Computer Manual Series No.12, Vienna (1997)
- Exergetic Cost Evaluation of Co-production Plants for Electricity and Potable Water, IAEA-TECDOC-942, Vienna (1997)
- Experience with Nuclear Heat Applications, IAEA-TECDOC-(in preparation)
- Introduction of Small and Medium Reactors in Developing Countries, IAEA-TECDOC-(in preparation)

IV. International Nuclear Desalination Advisory Group (INDAG)

18. The Agency established the International Nuclear Desalination Advisory Group (INDAG). The main functions of INDAG will be:

(a) To provide advice and guidance on the Agency's activities in nuclear seawater desalination and review progress;
(b) To identify important topics for status reports, CRPs, technical meetings and topical conferences in the field of nuclear seawater desalination;
(c) To provide a forum for the exchange of information on the progress of national and international programmes in this field; and
(d) To provide advice on relevant action to concerned Member States for implementing nuclear seawater desalination demonstration projects.

The first meeting of the INDAG is scheduled for September 1997.